Soil carbon - Risks and opportunities in Aotearoa

The following questions were asked during our live webinar with Paul Mudge but due to time restrictions, we were unable to answer these in the session.

Do you see any benefit or limitations of farmers monitoring soil carbon concentration as part of their routine soil fertility assessment?

It depends on the aim of the measurements. There could be value in these measurements to track changes in carbon concentrations as an indicator of soil health, but not if wanting to accurately quantify changes in soil carbon stocks.

Does the national benchmarking five broad land use classes include forestry land use?

No, but baseline soil carbon has previously been systematically quantified in both exotic and native forests.

Where should we look for that information about soil carbon in forests?

Contact the Ministry for the Environment.

When do you estimate that accurate national soil carbon model will be complete?

We should have an updated version with some ability for spatial predictions in 6-months to a year (depending on funding). It will always be a work in progress to some degree. We want to make the process to update the system with new data simple and efficient.

Do we know the carbon saturation limits of the various soil types or soil orders?

Yes, previous research made estimates for these limits for soil orders across NZ (see link to one paper below). It is important to note that further research is required to determine how much (if any) of the theoretical sequestration potential could be filled in practice.

Soil carbon sequestration potential of permanent pasture and continuous cropping soils in New Zealand - McNally - 2017 - Global Change Biology - Wiley Online Library

Is there any evidence of a link between LUC class and carbon sequestration capacity?

LUC is largely defined by the inherent properties of the soil/land and also climate, rather than more dynamic soil properties like soil carbon and nutrients.

It would be relatively easy to run an analysis looking at the relationship between LUC and soil carbon stocks (based on our national C map). The sequestration capacity is a more nuanced

discussion – both current stocks and potential storage (if any) from a current state are also related to land use history.

What do you believe is the reason irrigated pasture has less C?

The paired site study was not specifically designed to understand the mechanisms as the focus was on quantifying soil carbon (& nitrogen stocks) at the adjacent sites. We did discuss some potential mechanisms, such as irrigation leading to lower allocation of carbon below ground to roots and increasing earthworm and microbial activity and thus increased CO2 loss via respiration.

What was the fertiliser regime for the mixed sward compared with the RG & WC?

Fertiliser regimes were similar for both swards and were as per typical (conventional) Canterbury dairy farm management.

Had the mixed species recently been cultivated for sowing compared with non-cultivated RG & WC pasture?

The areas under the two species treatments had the same cultivation history. Both were established following five years of lucerne. The sward comparison study presented in the webinar was established on the irrigated site described in the paper at the link below.

Irrigation increases forage production of newly established lucerne but enhances net ecosystem carbon losses – ScienceDirect

With the mixed sward pasture do you have an average composition of plant species? (i.e. what is the make-up)

The biggest difference between the two swards was the Italian ryegrass. Plantain only made up about 2-8% of the sward.

Is there any indication that there is a particular species in the mixed sward responsible for the lower C e.g. Italian RG? Given some of the species in the mixed sward are the same.

We didn't have enough resources to make detailed measurements at a finer scale to untangle the specific mechanisms driving differences. This was a paddock-scale systems comparison of the integrated effect of the different swards.

From my perspective, that final step in the slide (where all the components come together) could be a decision-making tool for famers and environmental managers (esp. in peatlands).

Yes, we want to develop such tools to help inform decisions on where to target different land uses and management practices aimed at maintaining or increasing soil carbon (at various scales, e.g., farm, catchment and national).

Slowing or halting losses on peatlands will be a huge challenge for NZ. They have significant investment, including pumping schemes to lower water tables, and restoration may only be possible by retiring land. Who pays and how do we break the status quo at a national scale?

Absolutely! I only very briefly touched on the biophysical aspects of subsidence and GHG emissions. Clearly decisions on future land use and management on peatlands will also have big cultural, social and economic implications (regardless of what decisions are made). How to break the status quo

and who pays for emissions from drained peat, the land if it is retired and who gets paid if restoration results in a GHG sink, are important questions that involve much more than the biophysical science. Retiring and restoring peatlands and considering alternative uses and values is the topic of significant interest internationally and there are examples of large-scale peatland restoration in both the UK and Europe. MWLR are actively developing research proposals in this space. We hope to bring you another (more detailed) webinar on this specific topic in the near future.

Peatland isn't included in the ETS yet and can't be used to offset (yet).

Yes, at present there are no monetary incentives at farm, industry or Govt. level to reduce emissions from drained peatlands, or to consider restoration for carbon storage. MWLR is currently working with MPI and MfE to improve emission accounting from drained peat soils.

We and our partners (e.g. Toitū) are also increasingly being contacted about this as a potential offset mechanism so we foresee changes coming here in the future. Additionally, large multinational companies (e.g. Nestle) have identified peatland restoration as a key activity for offsetting carbon emissions and it is possible large multinational companies will consider avoiding sourcing produce derived from drained peatlands in future.

Would be great to see the carbon t/ha model over time, particularly focussing on degradation.

Direct monitoring of soil carbon stock changes over time is a significant undertaking. We are just at the beginning of this work and will continue to update as it progresses.

We will also look to provide updates on progress with modelling changes associated with land use and management. Hopefully we will see a pattern of maintenance or improvement rather than degradation.

Link between Carbon and the new NPS on Highly Productive Land?

In this case highly productive land is largely defined by the inherent properties of the soil/land and also climate, rather than more dynamic soil properties like soil carbon and nutrients.

How can we become involved with the benchmark sampling regionally?

At present we are only sampling from the sites randomly generated as part of the original study design to ensure unbiased estimates at the national scale.

However, a number of farmers have expressed interest in being involved, so there could potentially be an opportunity to explore avenues for broader involvement.

Are you working with Labs (e.g., Hills) to gain access to their data on carbon based on soil sampling we do (anonymised)? Would dramatically increase sample size/data pool…

Yes, we have discussed this with labs and obtained some anonymised data for mapping purposes. However, sampling is generally only shallow and does not include bulk density so isn't particularly useful for determining 'profile' carbon stocks.

How labile is the carbon in NZ's stock of Carbon?

The lability of carbon in the soil really depends on the soil type, land use and management. Not a lot of research has been carried out for NZ soils in this respect. There are measures that we can do to estimate this for a given soil, but this is something that could benefit from further research to complement the national monitoring programme. This could provide an indication of the vulnerability of carbon to being lost.

In the dryland vs irrigated pasture trial, did you account for stock movements? Stock are more likely to camp on the unirrigated part of the paddock.

Good question. We were aware that in some cases stock might camp on dry areas so were careful about site selection. I sampled a good number of the 124 paired sites and there were no obvious differences in dung deposition. There were also some paired sites where dryland and irrigated areas were separate paddocks and on average results were similar for these sites. We also did an analysis considering the proportion of paddock in dryland vs irrigated and there was no effect on results. If transfer was a major factor, we would have expected differences to be greater where dryland areas were smaller. However, we can't rule out that stock movement did not contribute to the observed results. This could be resolved from direct observation and quantification of animal movement and excreta deposition at each of the 124 sites, or sampling more adjacent paddocks which are fully irrigated and unirrigated (noting that such sites can be hard to find and are likely to differ substantially in management practices in addition to irrigation). An alternative is to repeat the well replicated Winchmore irrigation experiment, wait a number of years and see if results are consistent with the previous experiment (~30 t/ha less C under the well irrigated than dryland treatment).

C under irrigation, being less in a pasture... will be same without stock? If some info about that?

Our previous work with cut and carry lucerne showed a net loss of carbon under dryland and irrigated conditions, but the irrigated site lost more carbon than the dryland site. This is summarized in the paper at the link below.

Irrigation increases forage production of newly established lucerne but enhances net ecosystem carbon losses – ScienceDirect

Not sure how familiar you are with He Waka Eke Noa and the ETS and how this relates to Agriculture - is Peatland included in this? i.e. can farmers offset emissions by having peatland?

Changes in peatland soil carbon stocks are not currently included in the ETS or the He Waka Eka Noa recommendations. Even if peatlands were included in some way, offsetting emissions would require evidence that a peatland had been restored and was acting as a carbon sink.

How much peatland is NZ? (What proportion of drained peatlands vs undrained peatlands?)

Historic mapping suggest national peatland area is about 250,000 ha (Fundamental Soil Layer) and our current emissions inventory estimates a drained area of about 167,000 ha of grassland. However, because updated soil mapping (S-map) has not been completed for large areas of NZ we are still uncertain about total peatland area and drained area. Of the undrained area a proportion of this will be impacted by surrounding land drainage.

Are the terms "soil organic matter" and "soil carbon" interchangeable?

No, the terms are not interchangeable, but there is a strong relationship between the two, with soil organic matter typically containing about 58% carbon. SOM includes other nutrients/elements, whereas SOC is just C.

There's a strong desire from pastoral farmers to be able to use any accumulated soil carbon as an agricultural emissions offset. What is needed, & is it possible, to calculate soil carbon accumulation at a single farm level?

We completed a short report on this topic for He Waka Eke Noa. It can be found at the link below.

Landcare Report (hewakaekenoa.nz)

Soil carbon and the NZETS? Soil Carbon and International ETS's?

Soil carbon is not currently included in the NZ ETS.

Changes in soil carbon associated with changes in land use are included in our national GHG inventory reporting. Measuring soil carbon | Ministry for the Environment. This modelling system could potentially be updated in future and could potentially include effects of land management.

Are any sites subject to short term water retention through detainment bunds?

No.

Should biochar be included in future soil carbon research?

Please see the recent NZAGRC commissioned review on this topic at the link below.

Potential-Role-of-Biochar-in-NZ-2021.pdf (nzagrc.org.nz)